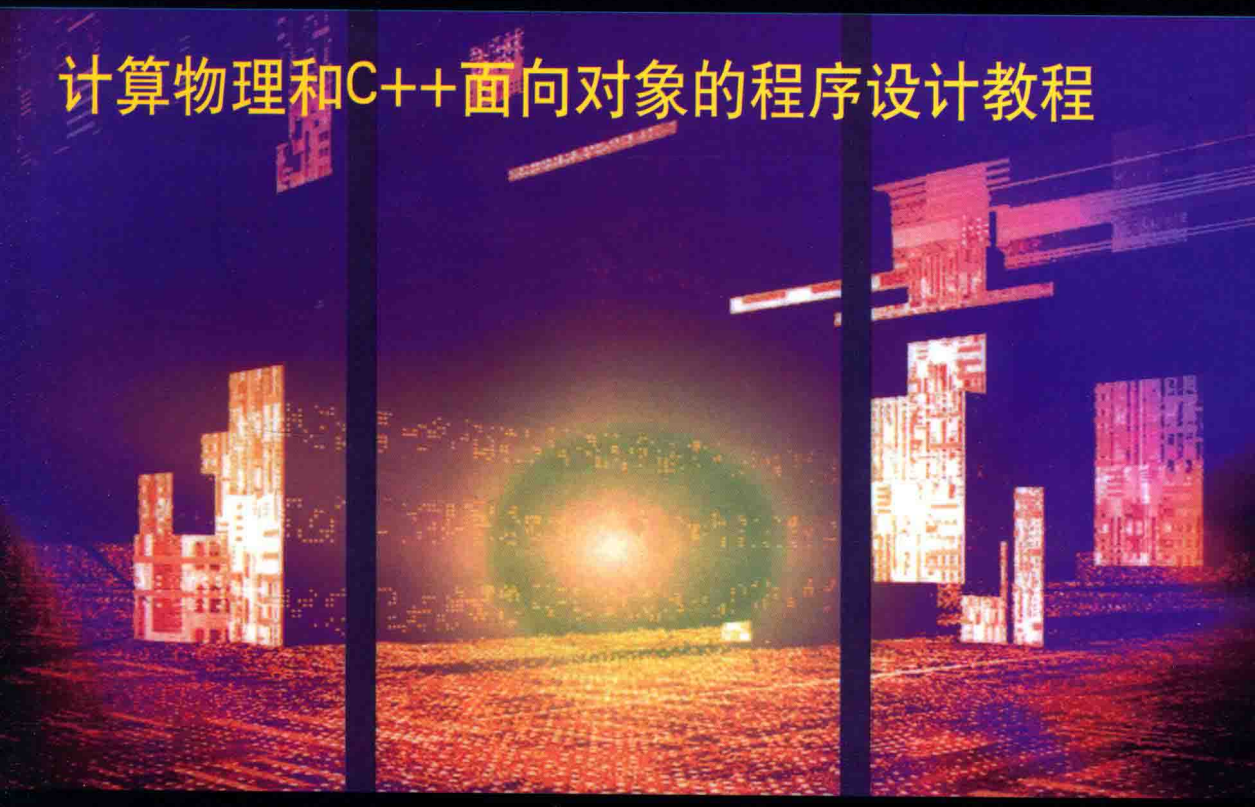
David Yevick

A First Course in Computational Physics and Object-Oriented Programming with C++

计算物理和C++面向对象的程序设计教程



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A First Course in Computational Physics and Object-Oriented Programming with C++

Because of its rich object-oriented features, C++ is rapidly becoming the programming language of choice for science and engineering applications. This text leads beginning and intermediate programmers step by step through the difficult aspects of scientific coding, providing a comprehensive survey of object-oriented methods.

Numerous aspects of modern programming practice are covered, including object-oriented analysis and design tools, numerical analysis, scientific graphics, software engineering, performance issues, and legacy software reuse. Examples and problems are drawn from an extensive range of scientific and engineering applications. An emphasis on the fundamental logical principles of the language, combined with short, focused illustrations and discussions, helps promote rapid learning. The book also includes a CD-ROM with a full set of free programming and scientific graphics tools that facilitate individual learning and reduce the time required to supervise code development in a classroom setting.

This unique text will be invaluable both to students taking a first or second course in computational science and as a reference text for scientific programmers.

DAVID YEVICK is a leading scientist in the application of numerical modeling to optical communication systems, notably guided electric field propagation in waveguides and fibers, optical processes in semiconductors, and most recently optical communication systems. Over the last 25 years, he has collaborated with numerous industrial and government research establishments, including spending four years with the IBM Center of Advanced Studies, Canada, on practical applications of the VisualAge for C++ toolset.

Dr. Yevick has extensive teaching experience in both electrical engineering and physics. Since 1999, he has been a full professor of physics at the University of Waterloo, Ontario having previously held positions in the Electrical and Computer Engineering Departments of Queen's University at Kingston and the Pennsylvania State University, in the Solid State Physics Department of Lunds Universitet and at the Institutet för Optisk Forskning, Stockholm. He has authored or co-authored over 120 refereed journal articles. Dr. Yevick is a fellow of the American Physical Society, the Institute of Electrical and Electronics Engineers, and the Optical Society of America and is a registered Professional Engineer, Ontario.

A First Course in Computational Physics and Object-Oriented Programming with C ++ (978-0-521-82778-2) by David Yevick, first published by Cambridge University Press 2005

To my parents, George and Miriam, who were the first to teach me physics and mathematics, my wife Susan for her unending support and to Ariela, Hannah and Aaron who I hope one day will find this book useful

Contents

Part I

C++ programming basics

Chapter 1
Introduction

This textbook is the result of seven years of experience with teaching scientific programming in both science and engineering departments. The book has a single, clearly defined goal – to convey as broad an understanding of the entire scientific computing field as possible within a single term course. Accordingly, while the C++ programming language is explained concisely, its conceptual foundation is emphasized. Once this framework is understood, the complex language syntax can be far more easily retained. Further, all features of modern programming of relevance to scientific programming are surveyed with emphasis on strategies for simplifying coding. Free software tools are included that minimize the technical hurdles of coding and running programs.

1.1 Objective

As stated above, this textbook presents a broad introduction to modern scientific programming. This includes numerical analysis, object-oriented programming, scientific graphics, software engineering, and the modeling of advanced physical systems. Consequently, knowledge of the material will provide sufficient background to enable the reader to analyze and solve nearly all normally encountered scientific programming tasks.

1.2 Presentation

This text is concise, focusing on essential concepts. Examples are intentionally short and free of extraneous features. To promote retention, the book repeats key topics in cycles of gradually increasing difficulty. Further, since the process of learning computer language shares many similarities with that of acquiring a spoken language, the most important sample program segments are highlighted in gray. *Memorizing these greatly decreases the time required to achieve proficiency in C++ programming.*